Claims

What is claimed is:

1. An isolated polarizing optical beam splitter/combiner for combining orthogonally polarized beams of light into a single port in a combining direction, or for splitting a beam of light into orthogonally polarized beams of light to spatially separated ports in a splitting direction comprising:

a single port for launching a beam of light into the splitter/combiner, or for outputting a combined beam of light from the splitter/combiner;

a pair of spaced apart ports for launching orthogonally polarized beams of light into the splitter/combiner, or for outputting orthogonally polarized beams of light from the splitter/combiner;

a first polarization beam splitter optically coupled to the single port, oriented to provide different optical paths for two orthogonally polarized beams of light;

a second polarization dependent beam steering means optically coupled to the pair of spaced apart ports, oriented to provide different optical paths for two orthogonally polarized beams of light;

a non-reciprocal rotator between the first polarization beam splitter element and at least an element of the second polarization dependent beam steering means for rotating a polarization of each of two orthogonal beams of light and maintaining the orthogonal relationship between them, said non-reciprocal rotator adapted to be driven for transmission in a selected combining direction or a splitting direction,

wherein, when driven in the combining direction, the non-reciprocal rotator permits light to propagate from the pair of ports to the single port, and prevents light from coupling between the single port and the pair of ports, or

wherein, when driven in the splitting direction, the non-reciprocal rotator permits light to propagate from the single port to the pair of ports, and prevents light from coupling between the pair of ports and the single port.

2. An isolated polarizing optical beam splitter/combiner as defined in claim 1, wherein the first polarization beam splitter element and the second polarization dependent beam steering means comprise a first and a second birefringent element.

3. An isolated polarizing optical beam splitter/combiner as defined in claim 2, wherein the first and second birefringent elements are located in object space or image space.

4. An isolated polarizing optical beam splitter/combiner as defined in claim 3, wherein the non-reciprocal rotator comprises a Faraday rotator.

5. An isolated polarizing optical beam splitter/combiner as defined in claim 4, wherein the non-reciprocal rotator further comprises a half wave plate.

6. An isolated polarizing optical beam splitter/combiner as defined in claim 5, wherein the non-reciprocal rotator provides a rotation of zero degrees in a selected direction and provides a rotation of 90 degrees in a reverse direction.

7. An isolated polarizing optical beam splitter/combiner as defined in claim 6, wherein the first birefringent element and the second birefringent element have rotational axes oriented substantially parallel or antiparallel to each other.

8. An isolated polarizing optical beam splitter/combiner as defined in claim 7, wherein at least one of the first birefringent element and the second birefringent element has an axis oriented for maximum walk-off between the different optical paths.

9. An isolated polarizing optical beam splitter/combiner as defined in claim 4, wherein the first birefringent element and the second birefringent element have rotational axes oriented at substantially 45 degrees to each other and the Faraday rotator provides a rotation of 45 degrees.

10. An isolated polarizing optical beam splitter/combiner as defined in claim 4, wherein the first birefringent element and the second birefringent element have rotational axes which together with a rotation of the non-reciprocal rotator provide efficient coupling in a transmission direction between the different optical paths of the first birefringent element and the different optical paths of the second birefringent element while substantially preventing coupling in an isolation direction.

11. An isolated polarizing optical beam splitter/combiner as defined in claim 3, wherein the non-reciprocal rotator includes at least a pair of aspherical lenses for collimating beams from the first birefringent element to the rotator and for focusing the beams for launching into the second birefringent element.

12. An isolated polarizing optical beam splitter/combiner as defined in claim 3, wherein the first birefringent element has an o-ray path and an e-ray path and the second birefringent element has an e-ray path and an o-ray path such that the e-ray path of the second birefringent element is optically coupled with the o-ray path of the first birefringent element and the o-ray path of the second birefringent element is optically coupled with the e-ray path of the first birefringent element,
wherein the different optical paths for two orthogonally polarized beams of light passing through both the first and second birefringent elements have a substantially same optical path length.

13. The isolated polarizing optical beam splitter/combiner as defined in claim 12, wherein the first and the second birefringent elements are substantially of a same optical length.

14. The isolated polarizing optical beam splitter/combiner as defined in claim 12, further comprising a third birefringent element and a second non-reciprocal rotator between the second birefringent element and the third birefringent element.

15. The isolated polarizing optical beam splitter/combiner as defined in claim 14, wherein one of the first, second and third birefringent elements has an optical length equal to a total optical length of the other two of the first, second and third birefringent elements.

16. The isolated polarizing optical beam splitter/combiner as defined in claim 1, wherein the first polarization beam splitter element comprises a birefringent beam splitter element, and the second polarization dependent beam steering means comprises a pair of birefringent elements having parallel wedge surfaces.

17. The isolated polarizing optical beam splitter/combiner as defined in claim 16, wherein the non-reciprocal rotator is disposed between the pair of birefringent elements.

18. The isolated polarizing optical beam splitter/combiner as defined in claim 17, wherein the pair of spaced apart ports are symmetrically disposed about an axis of an input lens for launching orthogonally polarized collimated beams at equal and opposite angles into a first of the pair of birefringent elements and for receiving orthogonally polarized focused beams.

19. The isolated polarizing optical beam splitter/combiner as defined in claim 18, further comprising a lens optically coupled to the single port for collimating a beam of light launched into the splitter/combiner or for focusing a combined beam of light output from the splitter/combiner.

20. The isolated polarizing optical beam splitter/combiner as defined in claim 19, wherein each birefringent element of the pair of birefringent elements has an optical axis disposed orthogonally to the other.

21. The isolated polarizing optical beam splitter/combiner as defined in claim 20, wherein the non-reciprocal rotator comprises a Faraday rotator and a half wave plate

arranged to provide a zero degree rotation in a transmission direction and a 90 degree rotation in an isolation direction.

22. The isolated polarizing optical beam splitter/combiner as defined in claim 19, wherein each birefringent element of the pair of birefringent elements has an optical axis disposed parallel to the other.

23. The isolated polarizing optical beam splitter/combiner as defined in claim 22, wherein the non-reciprocal rotator comprises a Faraday rotator and a half wave plate arranged to provide a 90 degree rotation in a transmission direction and a zero degree rotation in an isolation direction.

24. An isolated polarizing optical beam splitter/combiner for combining orthogonally polarized beams of light into a single beam of light in a combiner mode of operation, and for splitting a beam of light into orthogonally polarized beams of light in a splitter mode of operation comprising:

a first birefringent crystal having different optical paths for light of orthogonal polarizations converging at a single first port for combining orthogonally polarized beams of light in the combiner mode, or diverging from the single first port for splitting orthogonal beams of light from a beam of light in the splitter mode and having a rotational axis;

a second birefringent crystal having different optical paths for light of orthogonal polarizations converging from a second and a third spaced apart ports for reducing a spatial separation between two orthogonal beams of light in the combiner mode, or diverging to the second and third spaced apart ports for spatially separating orthogonal beams of light split by the first birefringent element in the splitter mode and having a rotational axis;

a non-reciprocal polarization rotator disposed between the first and second birefringent crystals for rotating the polarization of orthogonally polarized beams of light to a first state in a transmission direction for optically coupling the first port to the second and third ports, and for rotating the polarization of orthogonally polarized beams of light to a

second state in an isolation direction which does not permit coupling between the first port and the second and third ports.

25. An isolated polarizing optical beam splitter/combiner as defined in claim 24, wherein a pair of output/input sub-ports at the different optical paths of the first birefringent element have a separation "d1" and wherein the second and the third spaced apart ports of the second birefringent element have a separation "d2" which is greater than or equal to "d1".

26. An isolated polarizing optical beam splitter/combiner as defined in claim 25, wherein "d1" is substantially equal to "d2/2".

27. An isolated polarizing optical beam splitter/combiner as defined in claim 25, wherein an optical path length between the first port and the second port and between the first port and the third port for beams of light of orthogonal polarizations are substantially equal.